CALIFORNIA HIGH-SPEED TRAIN

Program Environmental Impact Report/Environmental Impact Statement

OPERATIONS REPORT

January, 2004

Prepared for:

California High-Speed Rail Authority

U.S. Department of Transportation
Federal Railroad Administration

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CALIFORNIA HIGH-SPEED TRAIN PROGRAM EIR/EIS

Operations Report

Prepared by:

Parsons Brinckerhoff, Inc.

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1.1 INTRODUCTION

This report documents the development and application of the operations simulation model for the proposed California High-Speed Train system. A network computer model was developed for the proposed high speed rail system serving the major metropolitan markets in California (San Diego, Los Angeles, Sacramento and the San Francisco Bay Area) to simulate train operations to contribute to defining the applicable engineering criteria, estimate travel times and speeds, and to develop the most effective rail operations plan(s) and planning level timetables. The model is a tool that accurately represents the physical characteristics of the proposed high speed rail alignment options as well as the performance of the high-speed train equipment that would operate on the system. Based on the alignment and train information the model provides comparisons of the high-speed train system performance and capacity across a variety of alignment options, station configurations, and specified levels of service. In addition, this model also provides a common platform from which to effectively interface with Amtrak, Metrolink, CalTrain, and the freight railroads (UPRR & BNSF) on rail operations and infrastructure issues on shared use corridors.

The Berkeley Simulation Software Rail Traffic Controller model was selected as the platform for the California High Speed Rail simulation model (the Model) developed for this analysis. The Model provides a range of analysis and reporting capabilities encompassing the range of information required for this analysis and can realistically simulate high-speed train operations in both a dedicated and operational environment (conventional freight and passenger with high-speed). The advantage of the Model is that it is designed as a flexible tool that can continue to be modified, refined and upgraded to evaluate different operational and infrastructure configurations.

A Business Plan and Program Environmental Process scenario were developed and simulated with the Model. The Business Plan scenario is based on the California High Speed Rail Authority's (Authority) Corridor Evaluation Final Report prepared in December 30, 1999 and the Program Environmental Process scenario builds on the Business Plan with further refinement of alignment and station locations and configurations developed during the program environmental process. The purpose of the Business Plan scenario was to confirm that the Business Plan assumptions are viable. The purpose of the Program Environmental Process scenario was to develop the facility sizing, speeds, travel time, and timetable for the High Speed Train alternative developed for the Draft Program Environmental Impact Report/Environmental Impact Statement (EIR/EIS).

1.2 MODEL APPLICATIONS

The Model was used for both the Business Plan and Program Environmental Process scenarios to:

- Evaluate train performance and alignment characteristics (speeds and travel times)
- Develop operating plans and refine service plans (time table)
- Identify infrastructure needs (tracks, stations, storage and maintenance facilities)

Each of these applications are required to define a High Speed Train alternative and test capabilities of the system, as described below.

1.2.1. Evaluation Train Performance And Alignment Characteristics

The model can accurately simulate high speed train operations based on trainset performance characteristics for a specified alignment option including different geometric parameters and infrastructure configurations. A Train Performance Calculator (TPC) is used to compute optimal (minimum) run times and operating speeds for trains running from one specified point to another over the rail network without interference from other trains for the full range of options being considered at a segment by segment level as well as at the systemwide level for specific combinations of potential alignment and infrastructure options. This TPC uses published trainset performance specifications including tractive effort and dynamic braking characteristics to replicate the dynamics of each train. A typical TPC output is presented in Figure 1 for illustrative purposes. As shown in this example, for a trainset composed of 12 Siemens type electric multiple unit (EMU) cars operating between Bakersfield and San Diego (a distance of 421.70 km) the total run time will be about 2 hours and 44 minutes. The figure also illustrates the train and track speed; the throttle application and dynamic braking activity; elevation; distance, speed and run time along the entire segment.

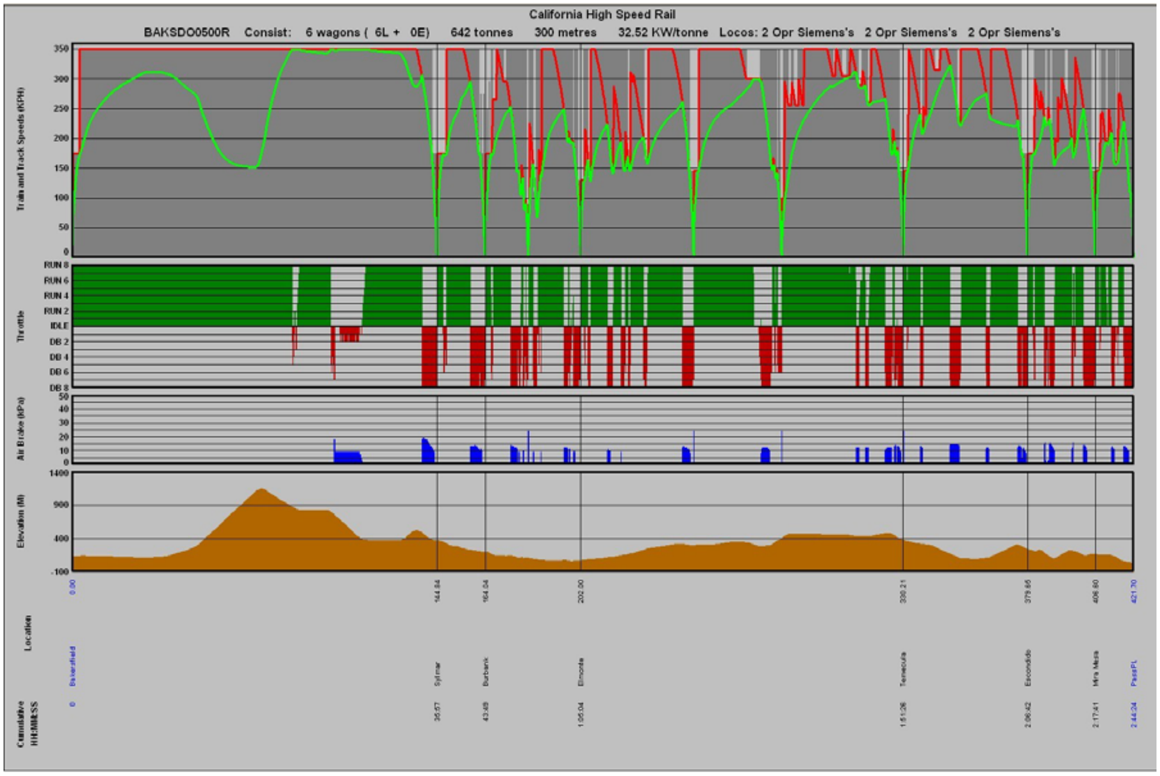

Figure 1: Illustrative Train Performance Calculator Output

Source: Parsons Brinckerhoff (2003)

1.2.2. Development Service Plans

The Model simulates train movements for each segment of operation and over the entire railroad network in order to develop realistic and efficient service plans. Based on the proposed infrastructure configuration and total number of trains, the required departure times, dwell times, and dynamics of trainset turns (the amount of time required to re-configure an arriving train to a departing train) are defined to develop a planning level timetable and test the capacity of the physical plant. Each simulation case analysis estimates a comparison of capacity and train delay at discrete levels of train service with a specified definition of infrastructure and physical characteristics. The simulation can measure performance of a specific train or all trains on the network and for a specific hour or for the complete service day.

The Model output was used to prepare stringline graphs (time/distance plots) as shown on Figure 2. For illustrative purposes, Figure 2 illustrates the service plan between San Diego and San Francisco between the hours of 4:30 AM and 1:00 PM. The Diagonal lines that run from the top to the bottom of the figure illustrate trains departing San Diego destined to San Francisco; for instance, Train SDOSFO090SE2 departs San Diego at 9 AM and arrives in San Jose at 12:15 PM. The diagonal lines that run from the bottom to the top of the figure illustrate trains departing San Francisco destined to San Diego; for instance, Train SFOSDO080B-2 departs San Francisco at 4:30 AM and arrives in Escondido at 1:00 PM. Stringlines charts are also useful for identifying where one train overtakes another train enroute, to plan for efficient timed-transfers or to identify and mitigate delays.

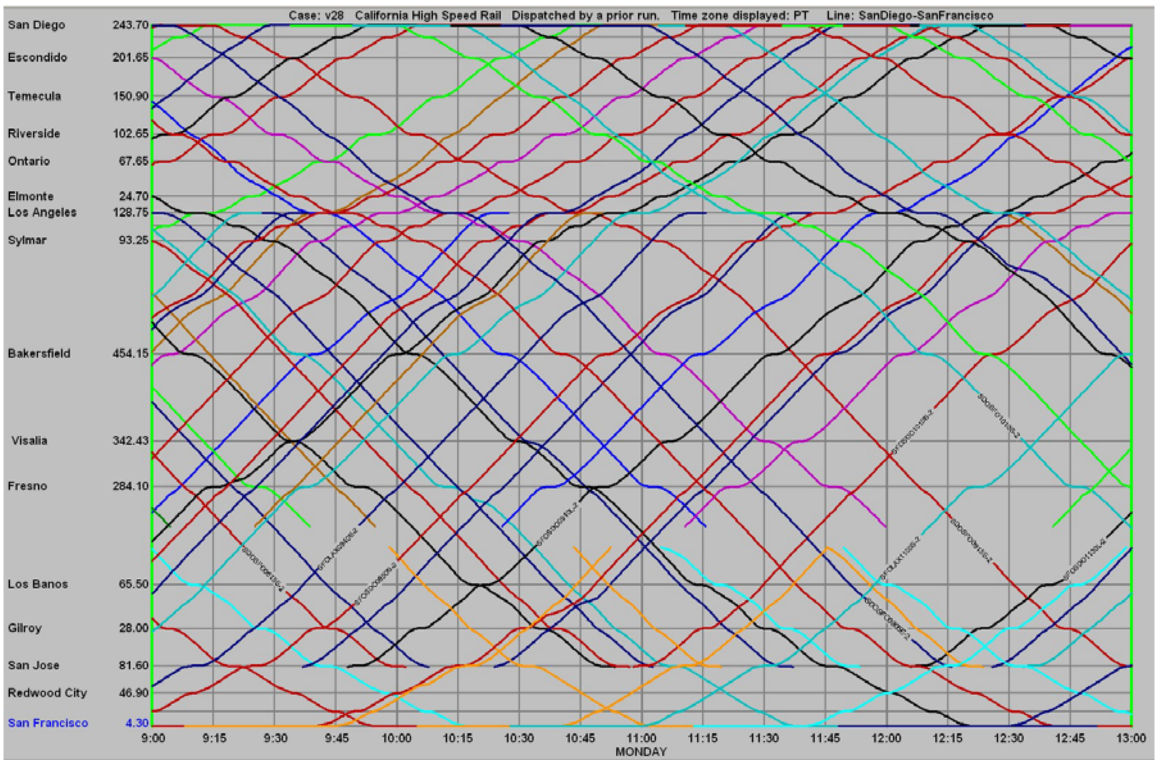

Figure 2: Illustrative Network Simulation Stringline Graph

Source: Parsons Brinckerhoff (2003)

The Model was also used to generate track occupancy charts that display trains occupying specific tracks at discrete points in time, as shown on Figure 3. Track occupancy charts are useful for evaluating track utilization at station platforms, particularly in terminal stations and to analyze the interrelationship between arriving and departing trains. For instance, for illustrative purposes as shown in Figure 3 for the San Diego Terminal, train SFOSAC1040S arriving on Track 2 eventually turns into departing train SACSFO1500S. These relationships are critical to determine the acceptable delay tolerances in developing a robust and realistic timetable.

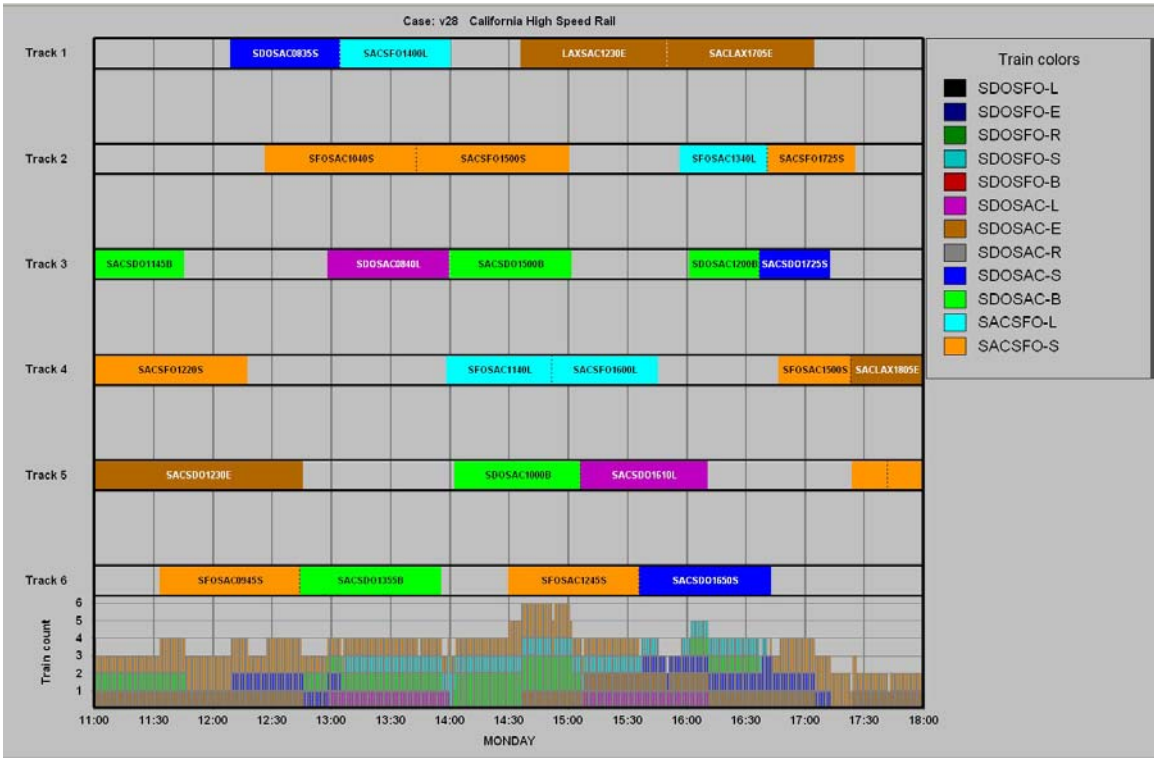

Figure 3: Illustrative Track Occupancy Chart for San Diego Terminal Station

Source: Parsons Brinckerhoff (2003)

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1.2.3. Assessment of Infrastructure Needs

The Model was used to evaluate the capacity of mainline segments and stations. For the purposes of the assessment of environmental impacts the model was used to identify infrastructure needs (physical extent of improvements) for the system based on the levels of train service estimated to accommodate the assumed ridership demand. Analyses were completed to define switch geometrics, crossovers, the number and configuration of station tracks and platforms, and the length of station siding (stopping) tracks. In addition, analyses were also completed to assess location and size of required storage and maintenance facilities.

The ability to simulate varying types of infrastructure configurations rationalizes train performance by identifying bottlenecks within the system and testing effective solutions to mitigate potential delays. For instance, Figure 4 shows an illustrative example of critical crossover placement for the approaches to a run through terminal station configuration (e.g., Los Angeles Union Station), where infrastructure needs are critical in managing the efficient operations of arriving and departing trains in a highly constrained physical environment. The Model was also used to determine whether a passenger station siding or additional main track segment is of appropriate length and location for the size and speed of the trains being operated, or to identify the optimal operating speeds to match a specific track configuration.

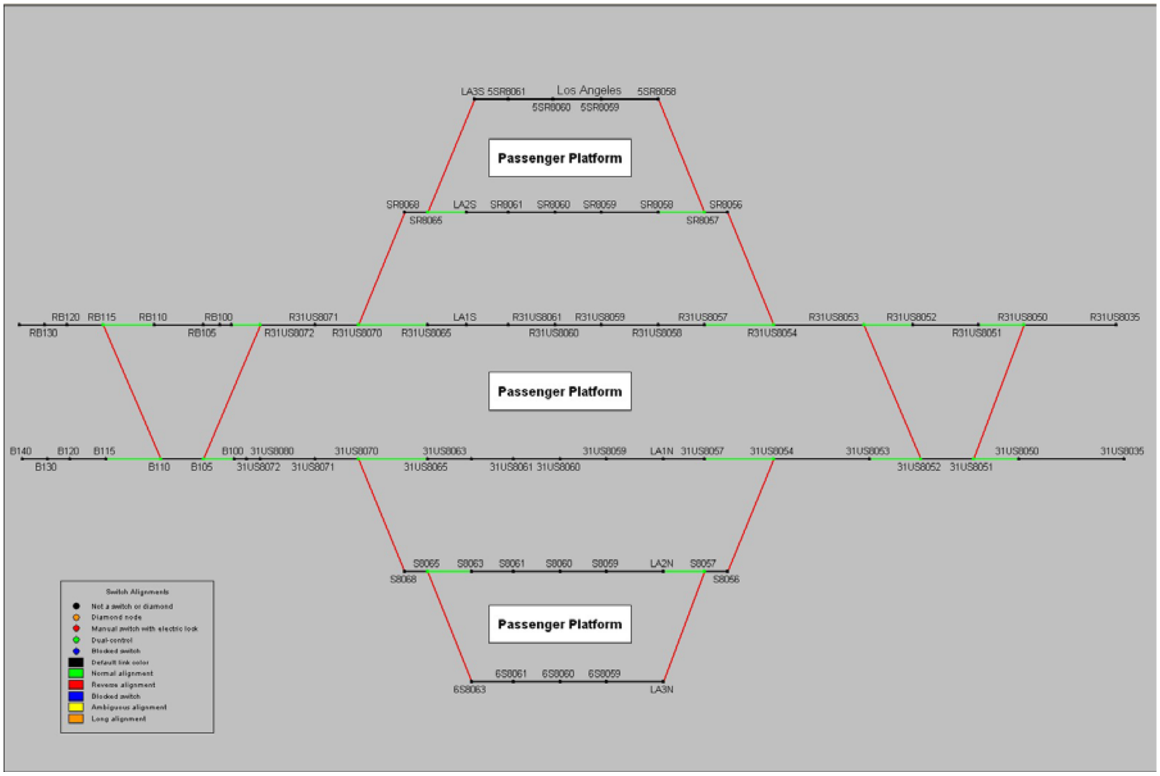


Figure 4: Illustrative Example of Crossovers at Los Angeles Union Station

Source: Parsons Brinckerhoff (2003)

2.1 INPUTS AND ASSUMPTIONS

This section identifies the critical inputs and assumptions used to developing the Model simulations runs. As mentioned above, two system network operating scenarios were tested including the CAHSRA's Business Plan and the Program Environmental Process. The key inputs and assumptions which are described below include:

- Train Characteristics and Specifications
- Alignment and Station Options
- Station Configuration
- Maintenance and Storage Facilities
- Service Plan

A key component to the Model input and assumption was the California High Speed Train Program EIR/EIS Engineering Criteria Report, prepared in July 2002. This report identified the engineering and operating parameters and assumptions to guide the definition of rail technology, alignment and station design, and operating and service plans.

2.1.1. Train Characteristics/ Specifications

Trainset characteristics and specifications define the type of rail vehicle fleet that will be used in the proposed service including, the locomotive and passenger cars. For both the Business Plan and Program Environmental scenarios the train characteristics and specifications were based on the Refined

Conceptual Operating Plan from the California High-Speed Rail Corridor Evaluation Final Report dated December 30, 1999 and assumed that the California High Sped Train will be:

- Steel-wheel-on-rail technology
- Capable of maximum operating speeds near 350 km/h (220 mph)
- Accommodate 650 passengers per train[1]

Table 1, summarizes the train set technologies considered for this analysis.

Table 1
Comparison of Representative Trainset Technologies

	Alstom TGV	Siemens ICE 3	Talgo 350	Japan Series 500	Japan Series 700
Train Configuration	L+8T+L	6M + 6T	L+12T+L	8M (1/2 Max Train)	6M+2T (1/2 max Train)
Train dimensions (meters)					
Length	200	300	280	204	204
Width	2.9	2.9	2.96	3.4	3.4
Height	4.1	3.9	4.0	3.7	3.7
Train Weight (tons)	424	662	320	344	392
Seating					
1st Class	3 cars (2x1) 120 seats	5 cars (2x1) 255 seats	N/A 282 seats	2 cars (2x2) 136 seats	2 cars (2x2) 136 seats
2nd Class	4 cars (2x2) 241 seats	6 cars (2x2) 408 seats	N/A 308 seats	6 cars (2x3) 526 seats	6 cars (2x3) 526 seats
Dining	16 seats	(dining area only) 24 seats	N/A	N/A	N/A
Total Seating Cap./ Train	377	687	590	662	662
Axles / Train					
Motored Axles	8	24	8	32	24
Total Axles	26	48		32	32
Train horse power	11,800	10,724	10,700	12,200	8,850
Max design speed (kph)	350 (P)	330	350	365	300
Max in-service speed (kph)	300 (P)	300	300	300	284

L= Locomotive T = Trailer M = Motor Car (P) = FOX Proposal for Florida HSR

Sources: Parsons Brinckerhoff December, 2000; based on published manufacturers' performance specifications.

[1] 1200 passengers per train was assumed for facility sizing in the program environmental analysis.

For the purposes of simulating both the Business Plan and Environmental Plan Analysis scenarios the train set performance specifications (i.e. tractive effort curve, braking effort curve, weight, etc.) are based on a twelve car, ICE -3 consist. This configuration was used because it most closely achieves the combination of capacity and performance objectives of the proposed California High Speed Train system. For the purposes of sizing station and maintenance facilities to serve the high-end ridership forecast, a 400 m, 1200 passenger trainset was assumed.

2.1.2. Alignment and Station Options

Several alignment and stations options were carried forward both in the Business Plan and Program Environmental Process scenarios. The alignments and station options in the Business Plan were developed and refined as part of the Corridor Evaluation Process that is documented in the Corridor Evaluation Final Report dated December 30, 1999. The alignment and station options in the Program Environmental Process are built on the Business Plan and further refined due to additional technical studies prepared as part of the environmental review process. In both cases, the alignment and station options were simulated to test the train operating characteristics and network impacts of those options.

2.1.2.1. Business Plan

The alignment and stations options developed for the 1999 Business Plan were based on limited engineering at a conceptual planning level. The alignment and station options that represented the best investment opportunities at the time and included two options as described below and shown in Figure 5.

> *Option A:* This route connects San Diego to Los Angeles via the Inland Empire and begins at a terminal station located at Qualcomm Stadium in San Diego. The Tehachapi Mountain crossing is achieved using the Antelope Valley (Palmdale)/Mojave Pass alternative. This option traverses the Central Valley via the West 99 corridor with the Pacheco Pass corridor to connect the Central Valley with the Bay Area. The Peninsula route is used to access the Bay Area with a terminal station at 4th and Townsend in San Francisco.

> *Option B:* This alternative follows the same route as Authority Option A (described above) with the exception of the Tehachapi Mountain crossing. This Option achieves the Tehachapi Mountain crossing using the I-5/Grapevine alignment via Santa Clarita, with a northerly heading that follows the SR-99 corridor into Bakersfield.

The horizontal and vertical physical characteristics data for Options A and B were developed as inputs for the simulation model in order to accurately represent distance, grades and curvature. The Model was built using these data to represent the high speed rail network.

2.1.2.2. Program Environmental Analysis

Subsequent to the publication of the Business Plan, in February 2000 the CAHSRA and the Federal Railroad Administration (FRA) initiated an alternatives screening process to identify the most reasonable and practicable HST alignment and station options for analysis in the Program EIR/EIS. The purpose of the HST Alignment/Stations Screening Evaluation was to consider all reasonable and practical options within all corridors being investigated by the CAHSRA and FRA at a consistent level of analysis and for the selected alignments to be carried forward into the Draft Program EIR/EIS process for further consideration and analysis. The HST alignment and station options were divided into five geographic regions or travel markets, and evaluated by five separate regional teams at a more detailed level than in the Business Plan. Given the potential for a wide range of impacts within the mountain passes, the Authority completed a review of tunneling considerations including a two-day conference and an alignment optimization and refinement effort using the Quantm system to assist in making the screening decision. The alignments and station options considered in the Program Environmental Analysis are illustrated on Figure 6.

Figure 5
High-Speed Train Corridors and Stations for Continued Investigation

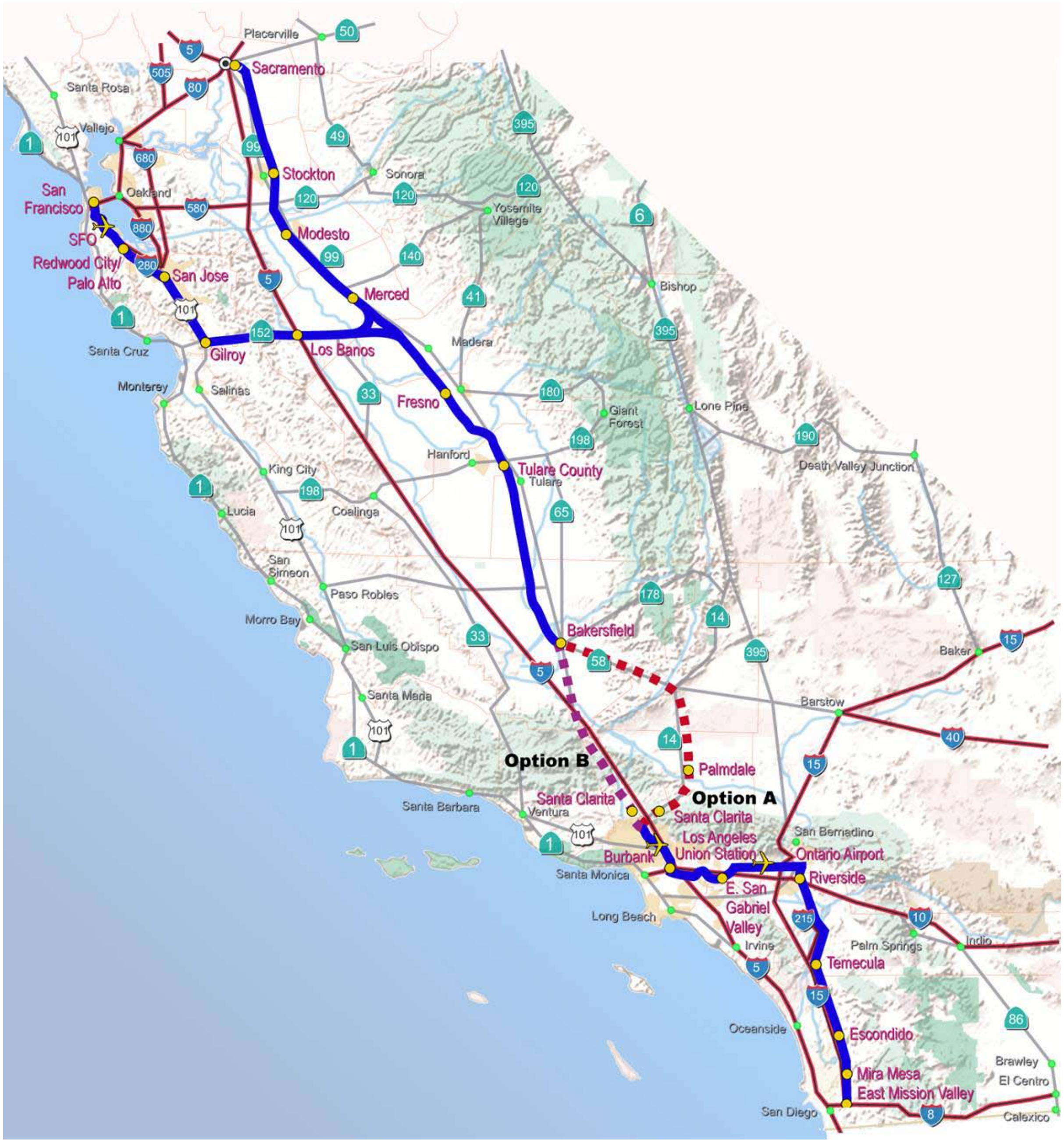


Figure 6
High-Speed Train Corridors and Stations for Continued Investigation

Within the alignment and station options identified in Figure 6, are several major design options including:

- Northern Mountain Crossing – mountain crossing options through the Coastal Mountain Range between the Central Valley and the Bay Area. Primarily two options: The Pacheco Pass through Gilroy and a northern crossing more directly aligned with San Jose.
- Southern Mountain Crossing – mountain crossing options through the Tehachapi Mountain Range between Los Angeles and Bakersfield. Primarily two options: The I-5 corridor and a route through the Antelope Valley.
- Bay Area – service to options to the Bay Area along the Peninsula to San Francisco and/or the east bay to Oakland.
- Southern California – service to Orange County in addition to service to San Diego via the Inland Empire and the I-5 corridor.
- Shared Use Options – service to the urban centers on shared tracks with other passenger rail services. Based on the screening evaluation, the state-of-the-art high-speed steel-wheel-on-steel-rail technology considered for the system must also be capable of sharing tracks with other services at reduced speeds in heavily urbanized areas (i.e., San Jose to San Francisco and Los Angeles to Orange County).
- Link to Los Angeles International Airport (LAX) – direct or transfer to other transit system.

Conceptual designs were developed for alignment and station options that include horizontal and vertical alignment (for grade and curves), profile, and general infrastructure cross sections. These data were input into the Model and the route alternatives for both the northern and southern California mountain crossings were combined with the other revised alignment route segments to observe running speeds and determine optimal express trip times.

Based upon the results of simulation analysis an optimized route alternative was selected to test the schedules based on the Business Plan service plan scenario of 172 trains per day (86 trains per direction). This route closely resembled the configuration of the Business Plan scenario and is described below and is illustrated on a Model network view in Figure 7:

- San Diego to Riverside via Qualcomm Stadium and Escondido SR-78/I-15;
- Riverside to Los Angeles via the UPRR (Segment 1-B);
- Los Angeles to Bakersfield via the Metrolink/UPRR Corridor, I-5 Wheeler Ridge Tehachapi Crossing;
- Bakersfield to Fresno via the UPRR Corridor;
- Fresno to San Jose via the UPRR Corridor and Pacheco Pass;
- San Jose to San Francisco via the Caltrain Corridor;
- San Jose to Oakland via the I-880 route (included to evaluate Bay Area service given constraints on the shared use Caltrain Corridor);
- Fresno to Sacramento via the UPRR Corridor to Lodi and crossing over to the BNSF at LODI to bypass Stockton, crossing back over to the UPRR alignment north of Stockton and continuing on the UPRR to Sacramento.

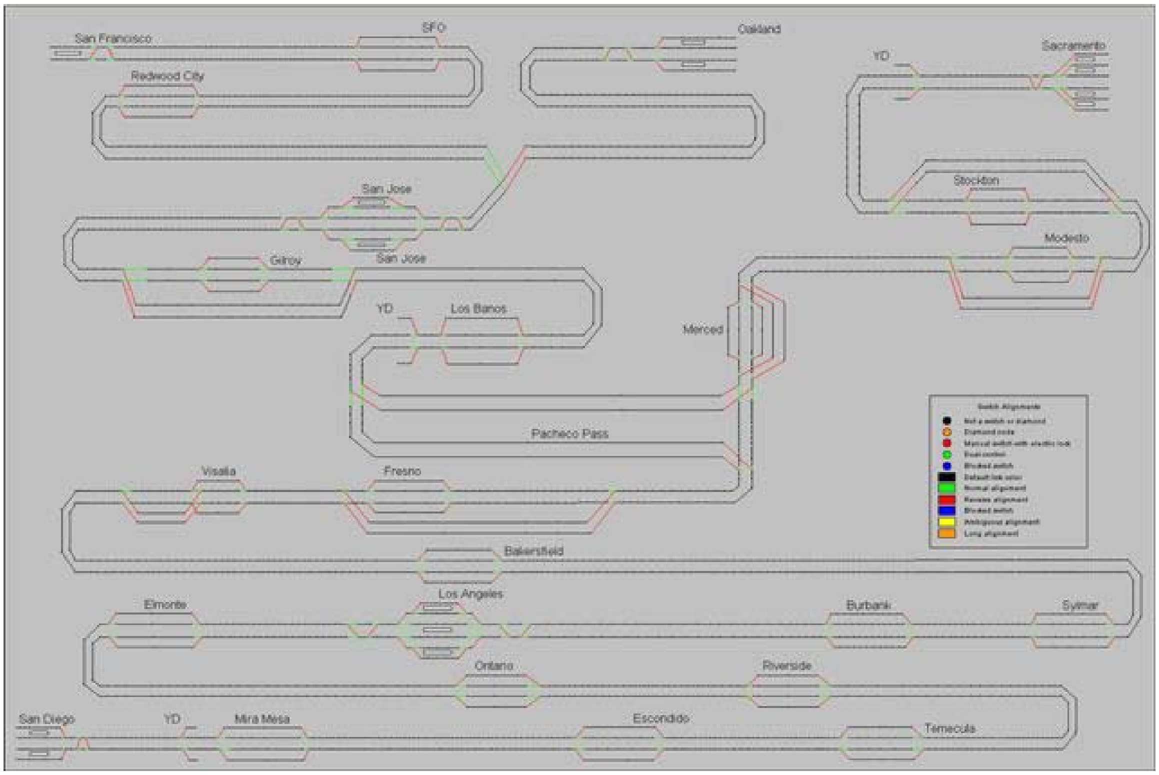


Figure 7: – Optimized Program Environmental Analysis Alternative – Statewide Network Simulation Model

Source: Parsons Brinckerhoff

2.1.3. Station Configurations

There are two principal types of stations that were considered in this analysis: terminus and intermediate. Terminal stations are those where all trains are planned to stop and perhaps lay-over during non-peak periods. All other potential stations are intermediate stations. Intermediate stations will provide off-line passenger platforms allow for pass-through express services on the dual track mainline. This section will describe the key inputs and assumptions used in the Model for both the Business Plan and Program Environmental Analysis.

2.1.3.1. Terminal Stations

The terminal stations for both the Business Plan and Program Environmental Analysis scenarios include San Francisco, Oakland, Sacramento, Los Angeles International Airport (LAX), and San Diego. Depending upon the examination of shared use issues on the LOSSAN Corridor and policy decisions affecting the high-speed rail system configuration end points and associated service, it was noted that a location in Irvine or Anaheim may ultimately be identified as a terminal station.

The Model was initially used to test different terminal station configurations and identify an optimum configuration to minimize delay. The layout which emerged from this analysis was a four track, two platform, "run-through" station as illustrated in Figure 8.

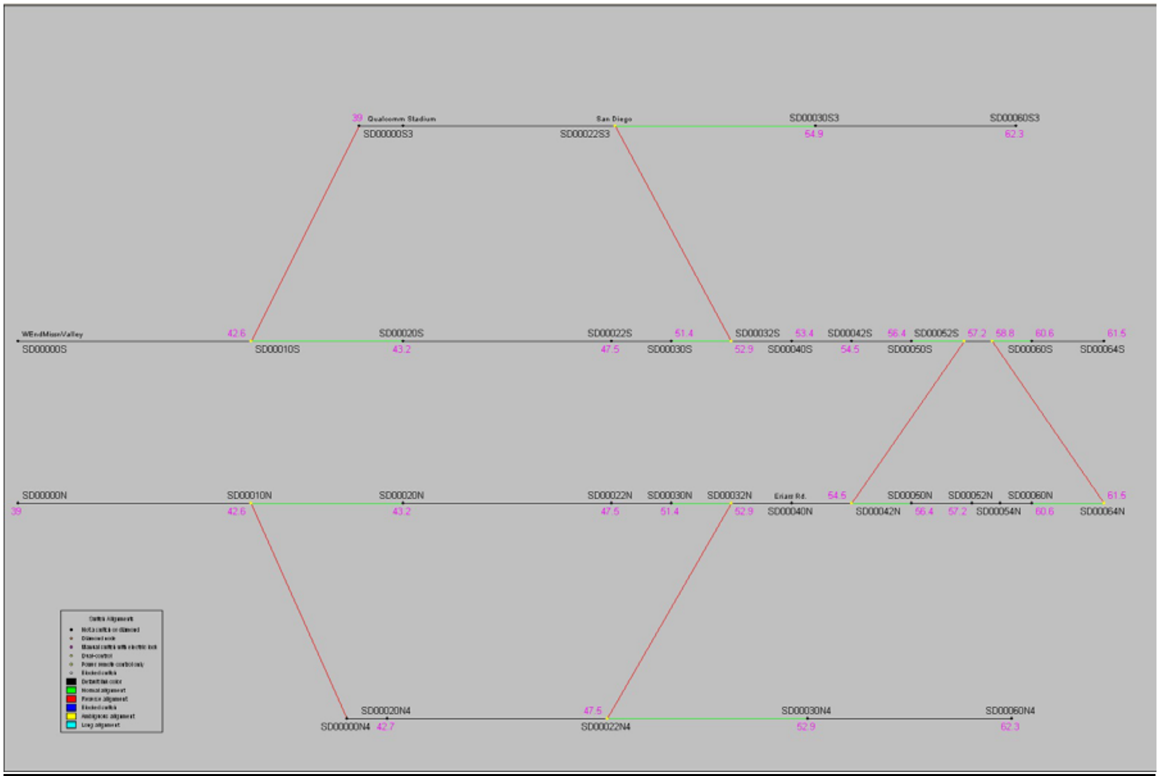


Figure 8: Illustrative Run Through Terminal Station

Source: Parsons Brinckerhoff

A key characteristic of terminal station performance is turnaround time: the time required to prepare an arriving train for a departing train, using the same trainset. The specific assumptions used in this Business Plan scenario analysis are summarized in Table 2 and are based on current U.S. passenger rail services and international high-speed rail practice that is appropriate and feasible for the service levels defined. The initially proposed terminal station configuration(s) were defined as a "run-through" station which provides:

- The ability to position arriving (from the main track or the storage yard) trains at the platform;
- Sufficient dwell times to allow passengers to alight or board and then dispatch the train in its original direction of travel either in revenue service onto the main track or as a deadhead (out of service) train set moving to a storage yard facility in proximity to the station.

Table 2
Initial Minimum Train Set Turnaround Time for Run Through Terminal Stations

Train Operation	Elapsed Time
Train Dwell Time in Station for Passengers Disembarking	5 Minutes
Travel Time from Station to Yard	5 Minutes
Contact Time in Yard for Inspection and Interior Cleaning	25 Minutes
Travel Time from Yard to Station	5 Minutes
Dwell Time in Station for Passengers Boarding	5 Minutes
Total Elapsed Time for Train set Turn-around	45 Minutes

Source: Parsons Brinckerhoff (2003)

During the Program Environmental Process analysis, the Regional Teams examination of potential station locations identified physical and environmental constraints having a direct impact on the ability to accommodate the initially proposed track and platform configuration at each site. Consequently, further refinement of these initially proposed configurations occurred as more detailed analysis of the potential sites by the Regional Teams became available. The results of these analyses and subsequent review by the Program Management Team re-defined the Terminal Station layouts and produced configurations that differed significantly from those previously described.

Due to extensive urban constraints, the terminal configuration with run-through capability initially developed for the Sacramento, San Diego, and Oakland Terminal Stations was re-configured to be "stub-end" for these stations. A stub-end station does not have run-through capability and the tracks in the station terminate in proximity to the end of the platforms; every train that enters the station must stop, dwell (to disembark, inspect, clean and board) and turn back in the direction from which it came in order to depart the station.

These terminals were changed from a run through station layout to stub-end stations because of land use spatial limitations emanating from the physical, environmental, and/or institutional constraints identified by the Regional Teams. A more detailed description of the stub ended stations operational characteristics is provided in section 3.1.3 later in this report.

2.1.3.2. Intermediate (Line) Stations

All other stations, not including terminal stations, are intermediate stations along the high-speed rail route and located between San Diego, Los Angeles, Sacramento and San Francisco. It is important to note that although locations such as Fresno and Bakersfield are, by definition, intermediate stations, these two locations originate service at the startup of the "service day" (in the conceptual service plan) and their configurations require two train storage tracks. In addition, there are some cases where off-line station areas or "by-pass" routes are being considered. In these cases separate tracks are diverted from the mainline dual track alignment to provide service to urban areas that cannot support the more rigid mainline geometric design requirements. For example, there are potential station locations serving communities in the San Joaquin valley, such as Stockton, where the main trunk of the High-Speed Rail Corridor will not pass directly through the town center.

The configuration for intermediate stations is an arrangement of two "off-line" tracks with side platforms, to allow pass-through express train service. The simulation model was used to test four different typical intermediate station configurations to identify the appropriate track geometry and siding length. Sidings measuring 3.5, 5, 7 and 9 kilometers long were examined in combination with the track geometrics, as shown for illustrative purposes in Figure 9.

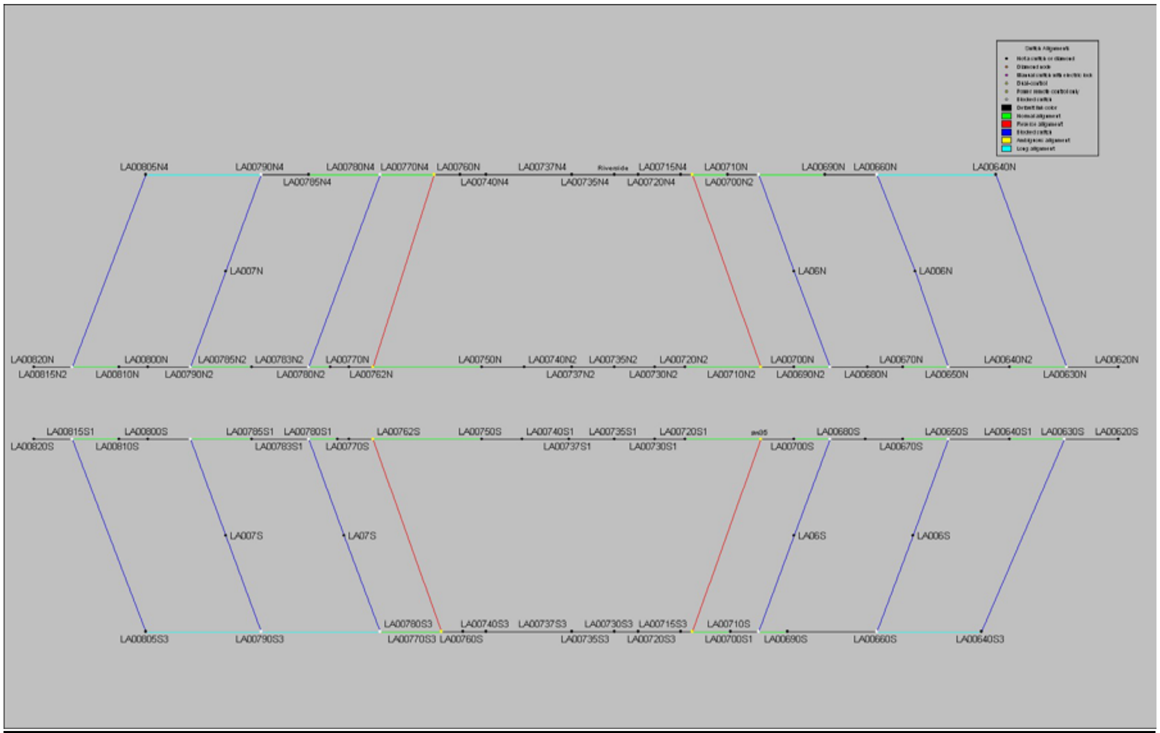


Figure 9: Illustrative Intermediate Station Configuration

The simulation analysis revealed that, in general, a siding length of 5 kilometers was the preferred arrangement. This arrangement provides for diverging speeds of 174 kph (108 mph) and allows for safe and efficient processing of both stopping and through movements and contributes to achieving travel time and system capacity goals.

Two exceptions to the definition of terminal and intermediate stations are the Los Angeles and San Jose stations. In both cases, because of the unique features of each station and their location within the high speed rail network, these stations have functions of both a terminal and intermediate stations and have been configured accordingly, as described below.

Los Angeles Station

Based on the conceptual service plan for both the Business Plan and the Program Environmental Process*,* the Los Angeles Station is a high volume passenger terminal. It is a "run through" station for service originating in San Diego, Sacramento and San Francisco as well as originating four trains at the startup of the service day.

The configuration initially proposed for Los Angeles Station was an arrangement of six tracks and three platforms. This preferred layout included data on track geometry and platforms which was developed as part of the simulation analysis. As shown in the station simulation model view in Figure 10, four different switch and crossover types (and associated diverging train movement speeds) were tested in the model to contribute to selecting the assumed Los Angeles Station configuration.

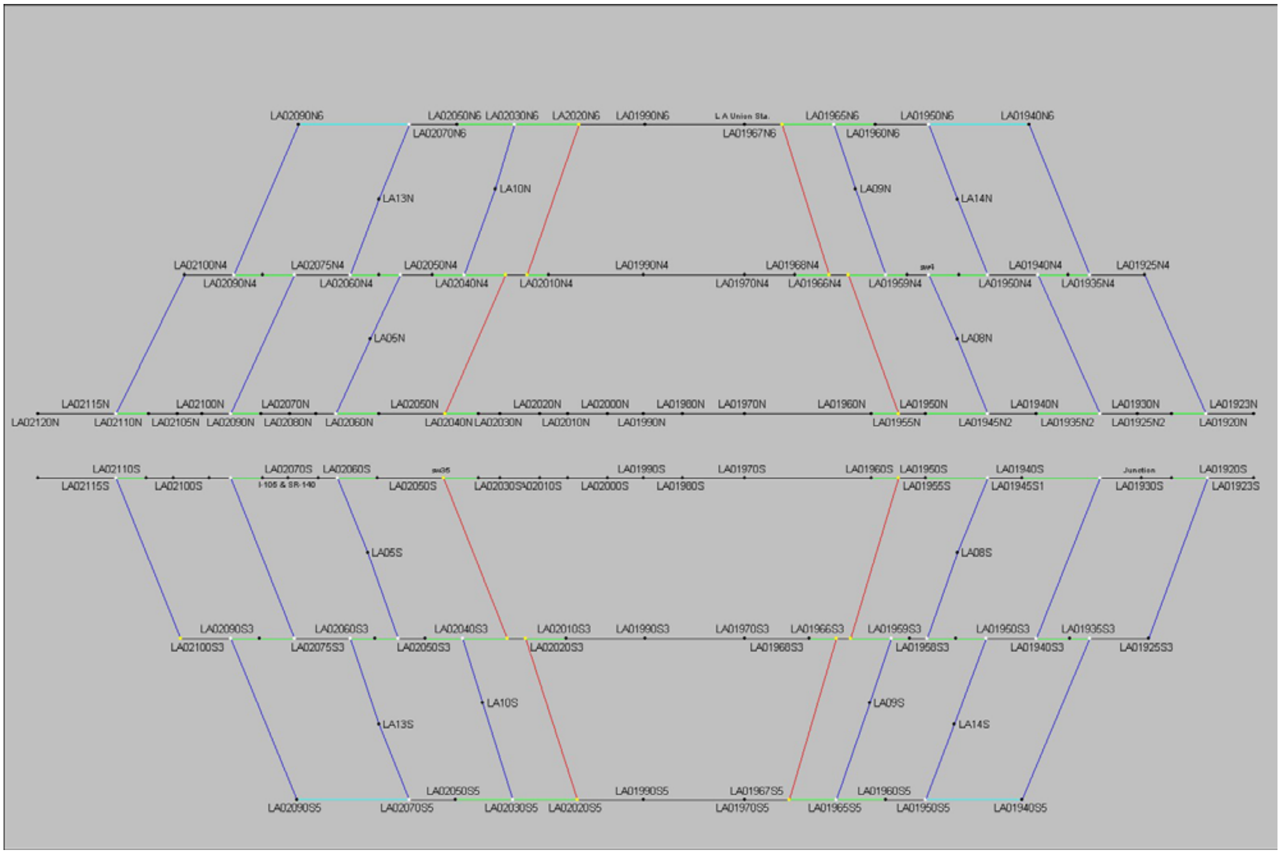


Figure 10: Los Angeles Station Conceptual Layout

Source: Parsons Brinckerhoff

San Jose Station

Based on the conceptual service plan for both the Business Plan and the Program Environmental Analysis, the San Jose Station is a "run through" station for service originating in San Diego, Sacramento and San Francisco. Although there are no trains originating at San Jose, there are several significant considerations that contribute to this station configuration requiring features of a terminal station.

Based upon the simulation analysis the Intermediate Station configuration previously described was adequate to support the number of trains specified to serve San Jose Station. However, it was determined that an alternative configuration be defined that is capable of supporting both future growth and potential modifications. Based on the simulation analysis, it was determined that San Jose station should be configured to accommodate additional train service and storage for the following reasons:

- Modest growth in the levels and frequency of service will require an additional station siding track to support the increased volume of train movements, particularly during peak periods when trains operate at closer headway intervals.
- The configuration and operating assumptions associated with the San Francisco Terminal and Storage Facility could change and may result in an increased volume of train movements and the need for additional storage at San Jose.

- The operational issues associated with a shared-use facility with Caltrain service along the Peninsula corridor may require additional train movements and storage capacity at San Jose.

Based on the assumptions above and the simulation analysis, the assumed configuration for San Jose Station is an arrangement of four tracks and two platforms. The four station tracks are "off-line" with the two main tracks of the High-Speed Rail Corridor passing in between. This configuration assumes a provision for growth, and changes in the operating and service plan (as described above). The computer model screen view depicting the San Jose Station is shown in Figure 11.

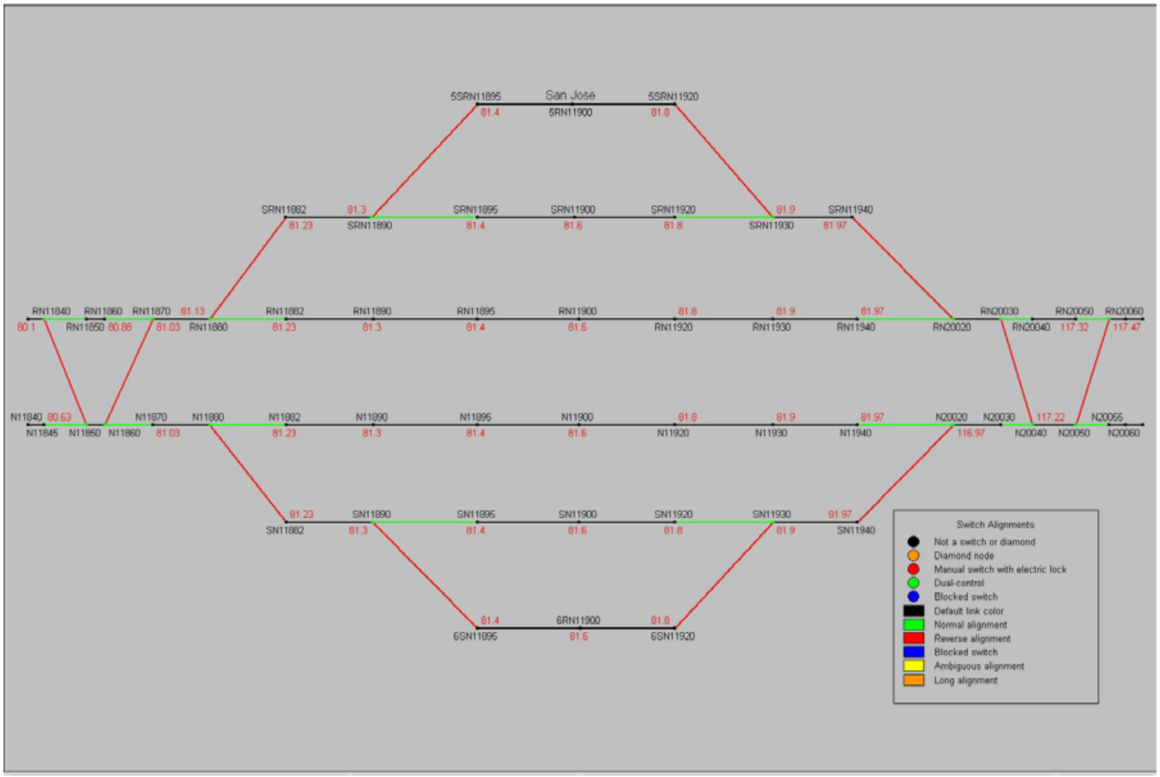


Figure 11: San Jose Station Conceptual Configuration

2.1.4. Maintenance and Storage Facilities

The general concept for storage and maintenance requirements is composed of storage, cleaning and inspection, and light maintenance facilities positioned at or in proximity to each terminal station. The configuration and location of these facilities on the network were included in the simulation analysis and were a key input to determining system performance and capacity. The assumptions for the Business Plan Case and Program Environmental Process scenarios are described below.

For each of the terminal station locations, an initial general configuration was developed for a maintenance and storage yard facility to support the service defined in the conceptual service plan (from the Corridor Evaluation Study). The assumed configuration for this facility includes tracks for "lay-up" (parking) for train sets, a Service and Inspection (S&I) facility for inspection and light maintenance, and a train washer located on the yard approach track for exterior cleaning prior to daily train storage. In addition, adjacent to the S&I facility, on a separate track, a wheel truing facility capable of accommodating two cars at a time was included.

In the previous section, the initially proposed station configurations defined the capability for trains to arrive at the station and then "run-through" to a storage yard facility. For each of the storage and maintenance facilities, the initially proposed configuration assumed that the distance of the two tracks connecting the terminal station and the storage yard is between 300 meters and 1500 meters.

In addition, a major repair and maintenance facility located (either near the Los Angeles "hub" station or near the center of the system (e.g., Bakersfield, Fresno or Merced) was defined. The facilities sizing was based on the greatest potential need (fleet size) associated with various operating scenarios assuming a potential fleet size of from 38 up to 55 trainsets (including a 10% spare ratio) depending on train consist size, mix of services and specific start-up assumptions. This conservative estimate of fleet size was further divided into storage needs at each terminal location based on potential operating scenarios. For the purposes of defining these general facilities, the following trainset storage requirements were assumed: Sacramento (8 trains), San Francisco/Oakland (14 trains), San Diego (21 trains), Los Angeles (3 trains), Fresno (2 trains) and Bakersfield (2 trains).

The results of the analysis by the Regional Teams identified potential Storage Yard layouts that differed from the initially proposed configurations described above for the run through terminal station concepts. These revised configurations, provide the same static capacity but, are located a greater distance from the proposed Terminal Stations and do not provide "run-through" capability. The re-defined configurations area based on the physical and environmental constraints identified by the Regional Teams and are described in detail later in this report in Section 3.1.3.3.

2.1.5. Operating/Service Plan

The timetables presented in the Final Business Plan (June, 2000) were the basis for the train data that was input to Model. The service levels tested in the system network simulation assumed for the Business Plan and Program Environmental Process scenarios were 86 trains per day in each direction; the service type and stopping patterns summarized below:

- Express (20 trains per day in each direction) – Trains running from Sacramento, San Jose or San Francisco to Los Angeles and San Diego with one intermediate stop between origin and destination.
- Semi-Express (21 trains per day in each direction) – Trains running between similar endpoints as the express, with a limited number of intermediate stops.
- Suburban-Express (20 trains per day in each direction) – Trains running "express" between major metropolitan regions, but stopping frequently within these regions.
- Local (21 trains per day in each direction) – Trains stopping at all intermediate stops with potential for skipping stops to improve service depending on demand.
- Regional (4 trains per day in each direction) – Trains running "local" that begin or end in the Central Valley, operating mostly during commute hours.

3.1 RESULTS (OUTPUT)

This section will summarize the key results of the simulation analysis for both the Business Plan and Program Environmental Process scenarios in terms of:

- Operating speeds
- Travel times
- Proposed station configurations
- Schedule and performance
- Shared-use corridors and other issues

3.1.1. Operating Speeds

For the HST system higher operating speeds (150 – 220 mph) are planned for the less constrained areas, in terms of alignment (i.e., flat and straight). In contrast, operating speeds are constrained to much lower speeds (<125 mph) in the more heavily developed areas. Figures 12 and 13 illustrate the maximum operating speeds for express service on each of the HST alignment options. Local and semi-express services do not necessarily reach these maximum speeds on a given segment.

Figure 12
Maximum Operating Speeds For
Express Service On Each Of The HST

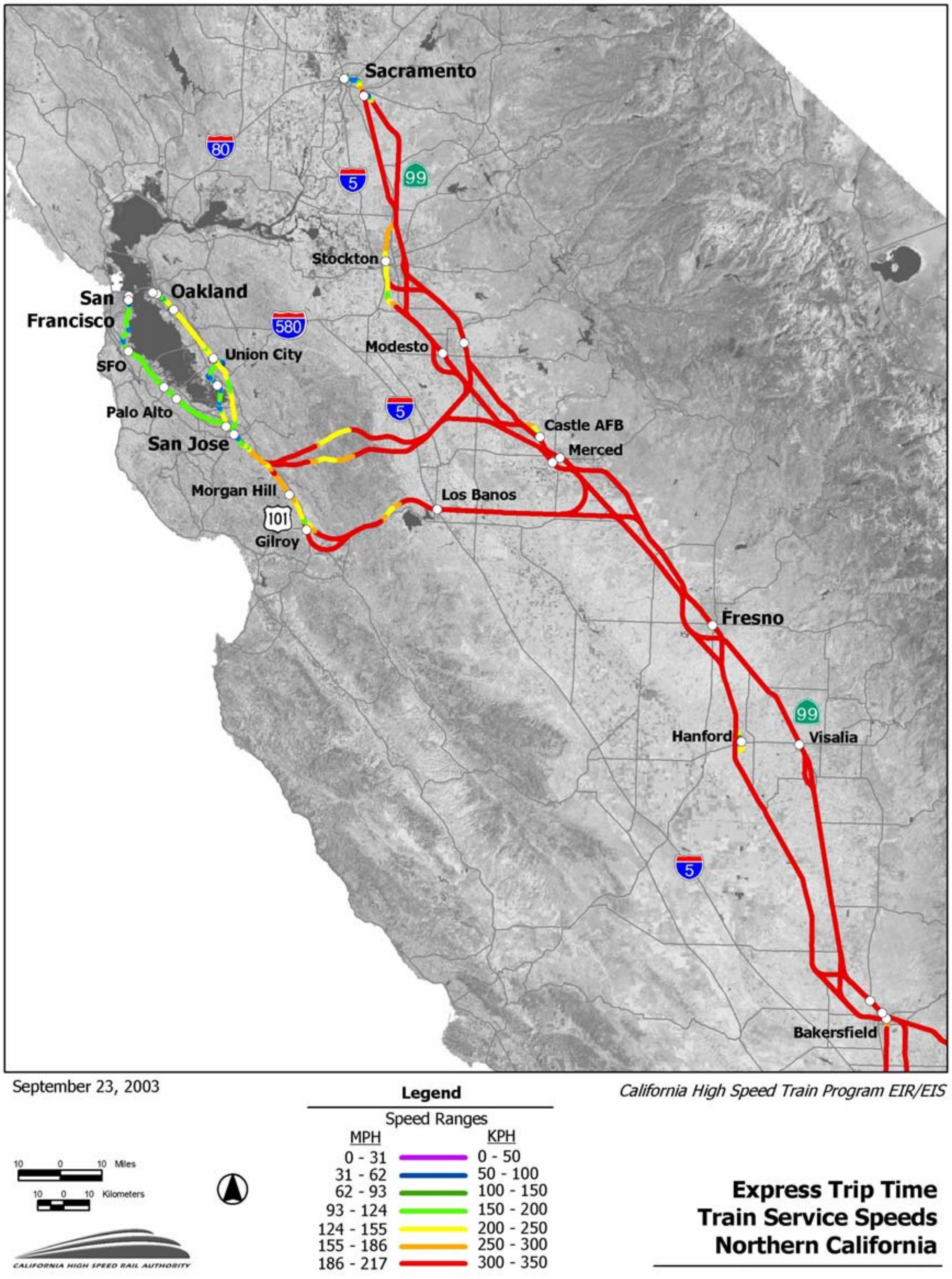
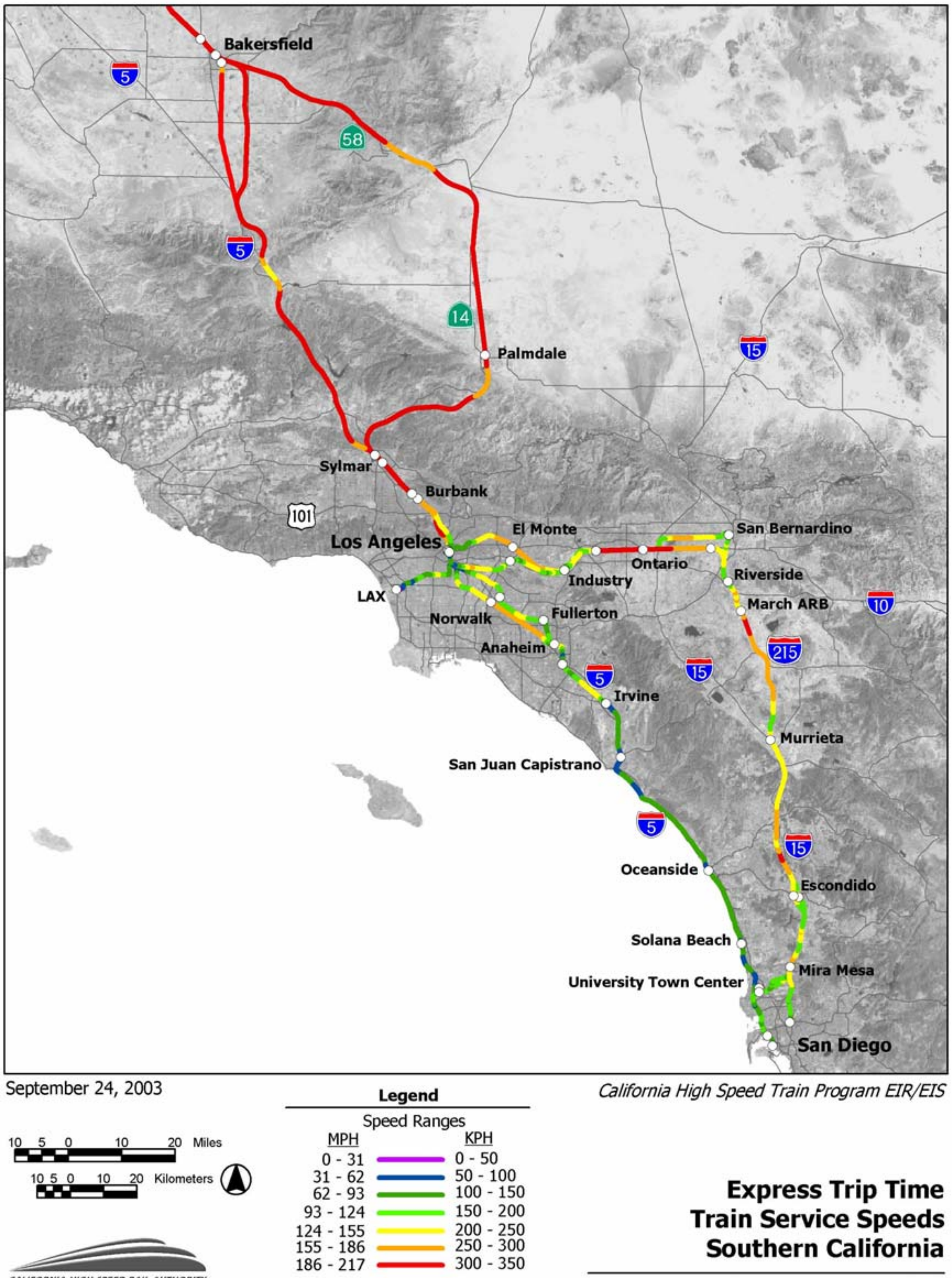


Figure 13
Maximum Operating Speeds For Express Service On Each Of The HST



3.1.2. Travel Times

Initially, specific route segments were combined to form eight different complete routes for the CAHSR system network configuration alternatives between San Diego, Los Angeles and San Francisco/Oakland and between San Francisco/Oakland and Sacramento as described below.

- *Alternative 1:* San Diego to Riverside via Qualcomm Stadium and Escondido SR-78/I-15; Riverside to Los Angeles via the UPRR (Segment 1-B); Los Angeles to Bakersfield via the Metrolink/UPRR Corridor, I-5 Wheeler Ridge Tehachapi Crossing; Bakersfield to Fresno via the UPRR Corridor; Fresno to San Jose via the UPRR Corridor and Pacheco Pass; San Jose to San Francisco via the Caltrain Corridor; Fresno to Sacramento via the UPRR Corridor.
- *Alternative 2:* San Diego to Riverside via Qualcomm Stadium and Escondido SR-78/I-15; Riverside to Los Angeles via the UPRR (Segment 1-B); Los Angeles to Bakersfield via the Metrolink/UPRR Corridor, I-5 Wheeler Ridge Tehachapi Crossing; Bakersfield to Fresno via the UPRR Corridor; Fresno to San Jose via the UPRR Corridor and the Diablo Range Direct with northern alignment option; San Jose to San Francisco via the Caltrain Corridor; Fresno to Sacramento via the UPRR Corridor.
- *Alternative 3:* San Diego to Riverside via Qualcomm Stadium and Escondido SR-78/I-15; Riverside to Los Angeles via the UPRR (Segment 1-B); Los Angeles to Bakersfield via the Metrolink/UPRR Corridor, Soledad Canyon SR-58 Tehachapi Crossing; Bakersfield to Fresno via the UPRR Corridor; Fresno to San Jose via the UPRR Corridor and Pacheco Pass; San Jose to San Francisco via the Caltrain Corridor; Fresno to Sacramento via the UPRR Corridor.
- *Alternative 4:* San Diego to Riverside via Qualcomm Stadium and Escondido SR-78/I-15; Riverside to Los Angeles via the UPRR (Segment 1-B); Los Angeles to Bakersfield via the Metrolink/UPRR Corridor, I-5 Wheeler Ridge Tehachapi Crossing; Bakersfield to Fresno via the BNSF Corridor; Fresno to San Jose via the BNSF Corridor and Pacheco Pass: San Jose to San Francisco via the Caltrain Corridor; Fresno to Sacramento via the BNSF Corridor and CCT alignment to Sacramento.
- *Alternative 5:* San Diego to Riverside via Qualcomm Stadium and Escondido SR-78/I-15; Riverside to Los Angeles via the UPRR (Segment 1-B); Los Angeles to Bakersfield via the Metrolink/UPRR Corridor, I-5 Wheeler Ridge Tehachapi Crossing; Bakersfield to Fresno via the UPRR Corridor; Fresno to San Jose via the UPRR Corridor and Pacheco Pass; San Jose to Oakland via the I-880 route; Fresno to Sacramento via the UPRR Corridor.
- *Alternative 6:* San Diego to Riverside via Qualcomm Stadium and Escondido Transit Center; Riverside to Los Angeles via the SB Loop Option (Segment 1-C) and the UPRR Colton Line; Los Angeles to Bakersfield via I-5 at Silver Lake and the I-5 Wheeler Ridge Tehachapi Crossing; Bakersfield to Fresno via the UPRR Corridor; Fresno to San Jose via the UPRR Corridor and the Diablo Range Direct with the tunnel under park alignment option; San Jose to Oakland via the Coast route; Fresno to Sacramento via the UPRR Corridor.
- *Alternative 7:* San Diego to Riverside via Downtown San Diego and Escondido SR-78/I15; Riverside to Los Angeles via the UPRR (Segment 1-B); Los Angeles to Bakersfield via I-5 at Silver Lake and Soledad Canyon SR-58 Tehachapi Crossing; Bakersfield to Fresno via the UPRR Corridor; Fresno to San Jose via the UPRR Corridor and Pacheco Pass; San Jose to Oakland via the I-880 route; Fresno to Sacramento via the UPRR Corridor.
- *Alternative 8:* San Diego to Riverside via Downtown San Diego, Miramar Road and Escondido SR-78/I15; Riverside to Los Angeles via the UPRR (Segment 1-B); Los Angeles to Bakersfield via the Metrolink/UPRR Corridor, I-5 Wheeler Ridge Tehachapi Crossing; Bakersfield to Fresno via the

UPRR Corridor; Fresno to San Jose via the UPRR Corridor and Pacheco Pass; San Jose to Oakland via the I-880 route; Fresno to Sacramento via the UPRR Corridor.

A graphic depicting each of the Alternatives described above and the maximum operating speeds for express service HST for each alignment option is presented in Appendix A.

A 12 car 300 meter train set based upon the Siemens ICE – 3 physical characteristics and performance specifications A representative trainset[2] was used in the model to test the Route Alternatives in the TPC simulations. The objective was to analyze running speeds and obtain optimal theoretical trip times for express trains over each alignment alternative. The first step in evaluating the route alternatives was to run the TPC simulation for the eight options to observe the dynamics of one trainset traversing the alignment without interference from other trains and determine optimal express trip times between the major city pairs in the network. The city pairs used and the Business Plan express travel times for comparison of the route alternatives are shown below in Table 3.

[2] A 12 car 300 meter train set based upon the Siemens ICE – 3 physical characteristics and performance specifications. Facilities were sized based on a 400 meter trainset.

Table 3
Business Plan Express Travel Times City Pair Summary

Travel Time (Hours:Minutes)	Los Angeles	San Francisco	San Jose	San Diego	Sacramento	Fresno	Bakersfield	Riverside
Los Angeles	-	2:30	2:02	1:00	2:09	1:19	0:47	0:29
San Francisco	2:30	-	0:31	3:29	1:40	1:15	1:47	2:58
San Jose	2:02	0:31	-	3:00	1:12	0:46	1:18	2:29
San Diego	1:00	3:29	3:00	-	3:07	2:17	1:46	0:34
Sacramento	2:09	1:40	1:12	3:07	-	0:53	1:25	2:36
Fresno	1:19	1:15	0:46	2:17	0:53	-	0:35	1:46
Bakersfield	0:47	1:47	1:18	1:46	1:25	0:35	-	1:15
Riverside	0:29	2:58	2:29	0:34	2:36	1:46	1:15	-

Source Parsons Brinckerhoff, 2003

The TPC simulations were utilized to test the performance of the train set over the selected route alternatives. A summary of the optimal theoretical express trip times between the Business Plan city pairs are presented in Table 4 these trip times are compared to the trip time goals specified in the Business Plan. Although because it closely resembled the "Option A" alignment from the Corridor Evaluation Study, the Alternative 3 trip times were compared to the "Option A" trip time targets. Optimal trip times between other city pairs are summarized in Appendix B.

Table 4
Optimal Theoretical Express Trip Times Between Business Plan City Pairs
(at 350 kph maximum speed)

Optimal Express Travel Times

Travel Time (Hours:Minutes)	Los Angeles		San Francisco		San Jose		San Diego		Sacramento		Fresno		Bakersfield		Riverside	
Los Angeles	-		2:25	2	1:56	2	1:06	7	2:00	5	1:12	1	0:41	6	0:30	7
San Francisco	2:25	2	-		0:30	1	3:30	2	1:27	2	1:18	2	1:47	2	2:55	2
San Jose	1:56	2	0:30	1	-		3:02	2	0:50	3	0:49	2	1:19	2	2:26	2
San Diego	1:06	7	3:30	2	3:02	2	-		3:07	5	2:19	1	1:49	4	0:39	1
Sacramento	2:00	5	1:27	2	0:58	2	3:07	5	-		0:53	5	1:23	5	2:30	5
Fresno	1:12	1	1:18	2	0:49	2	2:19	1	0:53	5	-		0:35	1	1:42	1
Bakersfield	0:41	6	1:47	2	1:19	2	1:49	4	1:23	5	0:35	1	-		1:12	4
Riverside	0:30	7	2:55	2	2:26	2	0:39	1	2:30	5	1:42	1	1:12	4	-	

= Reduction

= Increase

1 Alternative 1 (as defined above in Section 3.1.2.)
2 Alternative 2 (as defined above in Section 3.1.2.)
3 Diablo, BNSF
4 Alternative 4 (as defined above in Section 3.1.2.)
5 Alternative 1 (as defined above in Section 3.1.2.) with the Stockton bypass
6 Union Ave, Truxton - LAUS
7 Alternative 6 (as defined above in Section 3.1.2.) via Colton Line

The Los Angeles to Bakersfield Trip Time in the "Longest Alignment Options" Table should be changed from 1:43 to 0:43. The !:43 is a typo.

The trip times presented in Table 4 are based upon a maximum speed of 350 kph on the HST system. It is important to note however, that the trainset characteristics applied to the simulation model were based upon the most current, available performance specifications at the time of simulation modeling which provided a maximum operating design speed of 330 kph. Since the CAHSR System infrastructure is assumed to support a maximum operating speed of 350 kph, the TPC simulation trip time results which were based upon a maximum running speed of 330 kph were adjusted to reflect a maximum running speed of 350 kph. Consequently, two trip time reports were prepared: the first report displays trip times based upon the TPC simulation outputs and the 330 kph design speed and the second report presents adjusted trip times based on the assumption that a train traveling between points on the alignment that would support 350 kph would actually operate at that higher speed.

The trip time results from the complete TPC simulations, as described above, are shown in the tables in Appendix C and the TPC speed profile graphs in Appendix D.

3.1.3. Refinement of Station Configurations

As part of the Program EIR/EIS process, the Regional Teams examined potential station locations in greater detail and identified physical, institutional and environmental issues which directly impacted the initially proposed track and platform configuration at each site. Consequently, further refinement of these basic configurations occurred and the revised configurations are described in the following sub-sections.

Sacramento, San Diego and Oakland Terminal Stations

The initially proposed terminal configuration with run-through capability initially developed for the Sacramento, San Diego, and Oakland Terminal Stations was re-configured to be "stub-end" for these stations. The configuration of a stub-end station is described below and is illustrated in the simulation model screen view in Figure 12 (for Sacramento station) below:

- The tracks in the station terminate in proximity to the end of the platforms and every train that enters the station must stop, dwell (to disembark, inspect, clean and board) and turn back in the direction from which it came in order to depart the station;
- There is no "run-through" capability as previously described for the preferred configuration.

These terminals were redefined as stub-end stations because of physical, environmental, and/or institutional constraints identified by the Regional Teams that imposed land use spatial limitations. These constraints precluded the location of the storage yards and their connecting tracks in proximity to the terminal stations as described in the initially proposed alternative. Therefore, it was necessary to develop a concept that integrated several of the basic maintenance and cleaning functions formerly defined for the Storage Yard in the "run through" concept into the revised terminal stations. Each layout includes "bi-level" maintenance platforms in addition to the station tracks and passenger platforms. The track and platform configurations of these stations were revised from a run through concept with 4 tracks and 2 platforms to:

- Sacramento: 6 tracks and 4 platform islands
- Oakland: 4 tracks and 2 platform islands
- San Diego: 4 tracks and 2 platform islands

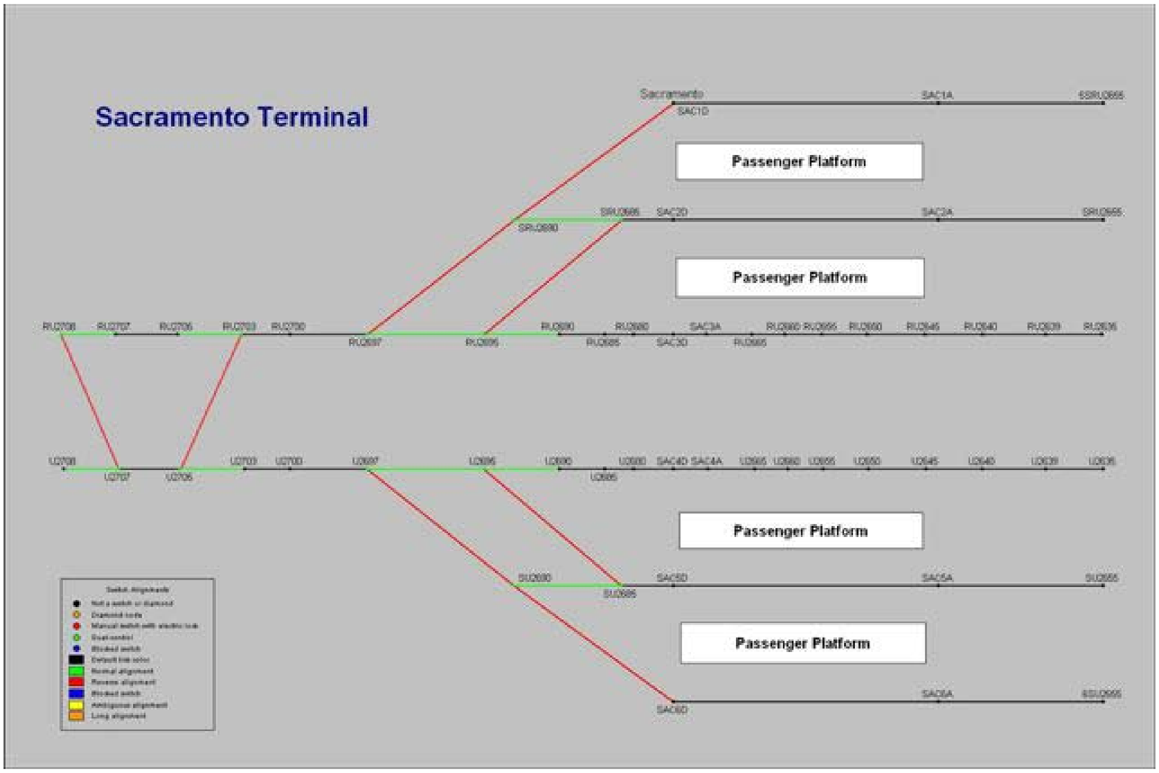


Figure 14: Typical Stub End Station (Sacramento Terminal Station)

Source: Parsons Brinckerhoff (2003)

San Francisco/Transbay Terminal Station

The conceptual operating plan that was assumed for the Business Plan proposed 66 trains (per day per direction - 132 total) to serve the Bay Area. Assuming dedicated use of four tracks and two island platforms by HST, the planned configuration of the Transbay Terminal could serve all of the trains proposed in the Business Plan. However, given the rail facilities planned for the Transbay Terminal (6 tracks and 3 platforms), the overall capacity available to accommodate HST and Caltrain commuter service would need subsequent cooperative operations planning analysis to determine the most efficient mix and scheduling of services to be accommodated. Any HST services (business plan levels or beyond) that are determined not to be accommodated at the Transbay terminal facility could terminate at other stations along the peninsula or East Bay.

3.1.3.1. Applying Revised Terminal Station Criteria

The Program Environmental Process simulation model tested these terminal station configurations (Sacramento, San Diego, Oakland and San Francisco) to validate the feasibility of reliably processing the number and type of trains specified in the conceptual service plan (from the CAHSRA Business Plan). The assumptions governing the dynamics of train movements (for inspection and cleaning, and turnaround) were modified to conform with the operational constraints inherent in the "stub-ended" configurations and are shown below in Table 5. These *minimum* train set turnaround time assumptions for an arriving *revenue train* making a "turn" for a departing *revenue train* are based on feasible, but operationally challenging practices currently applied in U.S. passenger rail services and international high-speed rail services.

Table 5
Revised Minimum Train Set Turnaround Time at Terminal Stations
Revenue Train to Revenue Train

Train Operation	Elapsed Time (minutes) Original (run-through)	Elapsed Time (minutes) Revised (stub-end)
Train Dwell Time in Station for Passengers Disembarking	5	5
Travel Time from Station to Yard	5	Not applicable to a stub ended station
Contact Time in Terminal Station Inspection and Interior Cleaning	**25**	**10**
Travel time from Yard to Station	5	Not applicable to a stub ended station
Dwell Time in Station for Passengers Boarding	5	5
Total Elapsed Time for Trainset Turn-around	**45**	**20**

Bold = Changed elapsed time assumptions

Source: Parsons Brinckerhoff (2003)

It is important to note that the reliable operation of the stub-end terminal station requires a high level of precision in dispatching trains and strict adherence to schedules on arrival, departure and minimum trainset turnaround times. Furthermore, although the simulation modeling of these terminals validated sufficient capacity to support the Business Plan service levels, their configuration presents a genuine potential constraint to future service growth, particularly during peak travel periods. Consequently, although not included in the simulation analysis, (except for Oakland) the physical characteristics defining an additional Terminal Station configuration alternative with trail tracks, was developed for both Sacramento and San Diego in the event that the physical and environmental constraints would allow such a configuration. These station layouts offer the advantage of improved operational flexibility (with limited run-through capability) contributing to a more consistent, reliable service and allow for some growth in the long term. Furthermore, the tail tracks provide important train staging and train storage capacity in proximity to the station.

In summary, the initially proposed Terminal Station (as described in the Engineering Criteria) was four tracks and two platforms in a run through configuration to a storage yard in proximity to the station. The results of the Regional Teams' evaluations indicated that land use or other constraints eliminated this optimal concept from further consideration. The next most desirable alternative would be the stub-ended configuration with tailtracks, if a land use scenario evolves that will support this concept. The stub-ended configuration with no tail tracks was applied to the network simulation modeling analysis of the Business Plan service levels, as summarized in Table 6. This terminal station configuration was assumed in the analysis because at the time of the simulation modeling it was the only feasible physical option presented in the Regional Teams' results.

Table 6
Revised Terminal Station Configuration

Terminal Station	Configuration
San Francisco	Stub-end: 6 tracks and 3 Platforms
Sacramento	Stub end; 6 tracks and 4 Platforms
Oakland	Stub end; 4 tracks and 2 Platforms
San Diego	Stub end: 4 tracks and 2 Platforms

Source: Parsons Brinckerhoff (2003)

3.1.3.2. Intermediate (Line) Stations

Initially four different typical intermediate station configurations were tested to identify the appropriate track geometry and siding length. As stated in the previous section of this report, sidings measuring 3.5, 5, 7 and 9 kilometers long were examined in the model to develop a preferred option for siding length which was assumed to be 5 kilometers. The speed of trains executing a diverging movement from the main track to the passenger station siding was the most prominent performance characteristic derived from this simulation analysis.

The Regional Teams reported that in some cases land use or other limitations required a modification to the recommended (preferred) typical intermediate station configuration. In these cases, a shorter station siding track length had to be considered to decrease the spatial area requirements influenced by this dimension. The shorter siding lengths examined in the Regional Teams analysis, reviewed by the Program Management Team were: 3500 meter siding length (145 kph-diverging speed); 2430 meter siding length (130 kph-diverging speed); 1280 meter siding length (100 kph-diverging speed), and a 940 meter siding length (90 kph-diverging speed). Final results of the evaluation of intermediate line passenger stations siding lengths and associated speeds for diverging train movement as applied to the network simulation model are presented in Table 7.

Table 7
Intermediate Stations – Siding Lengths

Station Name	Length (meters)	Diverging Speed (KPH)
Escondido	5000	174
Burbank	5000	174
S. Clarita	5000	174
Stockton	5000	174
Modesto	5000	174
Redwood City	5000	174
Fresno	5000	174
Bakersfield	5000	174
Merced	5000	174
Visalia	5000	174
Mira Mesa	3500	145
Temecula	3500	145
Ontario	3500	145

E. San Gabriel (El Monte)	2430	130
Los Banos	2430	130
Riverside (UCR)	1280	100
SFO	940	90
San Jose	940	90
Gilroy	940	90

Source: Parsons Brinckerhoff (2003)

The impacts that the shorter siding lengths and slower diverging speeds had on system performance and service delivery versus the preferred length of five kilometers was determined in the full dispatch network simulation described in a later section of this report.

3.1.3.3. Storage Yards and Maintenance Facilities

As previously described the HST simulation Model was used to define an overall operating and maintenance concept that meets the demand according to the Business Plan ridership forecasts and the associated conceptual service plan identified in the Business Plan. The results of the analysis by the Regional Teams identified potential Storage Yard layouts that differed from those preferred configurations as previously defined in the run through terminal station concepts. These revised configurations, provide the same static capacity but, are located a greater distance from the proposed Terminal Stations and do not provide "run-through" capability. The re-defined configurations based on the physical and environmental constraints identified by the Regional Teams are summarized below.

Sacramento: The revised storage yard concept is located approximately 13 kilometers from Sacramento Terminal Station (south of Alpine Avenue, north of Elder Creek Road, east of Power Inn Road, west of Florin Perkins and parallel to the UPRR main track alignment). This arrangement provides track lengths that accommodate one 400 meter train set or two 200 meter train sets on each track. It provides a configuration which supports the conceptual service plan (nine train sets). The revised storage yard concept is composed of eleven tracks, and assumes inclusion of a wheel truer, train washer and S&I facility.

Los Banos/Merced: The revised storage yard concept is located approximately 200 to 300 kilometers from San Francisco/Transbay Terminal Station (in the Central Valley). This arrangement is based upon track lengths that accommodate one 400 meter train set or two 200 meter train sets on each track. It provides the configuration which supports the conceptual service plan (fifteen train sets) for the Bay Area; San Francisco and Oakland. The revised storage yard concept is composed of sixteen tracks, and assumes inclusion of a wheel truer, train washer and S&I facility.

San Diego: The new storage yard concept is located approximately 8 kilometers from San Diego Terminal Station (Qualcomm option; immediately north of the Soledad Freeway and parallel to the Escondido Freeway). This arrangement is based upon track lengths that accommodate one 400 meter trainset or two 200 meter trainsets on each track. It provides the configuration which supports the conceptual service (twenty-one trainsets) plan (from the Corridor Evaluation Study) with dimensions that are a combination of the shortest length and greatest width. As shown in Figure 4.5-3A, the revised storage yard concept is composed of twenty three tracks, and includes a wheel truer, train washer and S&I facility.

The Network Model simulated these storage yard configurations and validated the feasibility of operating and storing the number and type of trains specified in the conceptual service plan. The operational characteristics and dynamics of train movements that emerged from the modeling for the revised terminal stations concepts were applied to dispatching trains to and from the revised storage yard concepts at the beginning and end of the service day.

In addition, a major repair and maintenance facility located (either near the Los Angeles "hub" station or near the center of the system (e.g., Bakersfield, Fresno or Merced) was defined.

3.1.4. Schedule/Performance

The results of the network simulation model with the revised Business Plan schedules accounting for the modifications described above are presented in the Appendix E Timetables. ***The simulation of trains operating over the network according to these revised schedules indicated that a system on time performance of 98% could be maintained for the 172 trains described in the Business Plan.***

3.1.4.1. REVISIONS TO THE BUSINESS PLAN SCHEDULES

Analysis of the initial Program Environmental Process Model results revealed that further refinement of the conceptual service plan schedules was necessary in order to develop the high level of reliability stated above. The prevailing objective during this step of the process was to preserve the original distribution of service types (i.e. express, semi-express, suburban etc.) and station stopping patterns while achieving the objective of 98% on-time performance. The aforementioned criteria was adhered to while rationalizing specific point to point running times in the full dispatch train schedules versus the optimal trips times developed in the TPC simulations and the Business Plan trip time goals . The most significant of these were addressed in schedule modifications as follows:

- Revisions to originating terminal station (i.e. San Diego, Sacramento, San Francisco, and Oakland) departure times were made to reduce the impact of overtake conflicts on running time. Departure times were generally modified in a range of plus or minus five minutes versus the Business Plan schedules departure times.
- Revisions to originating terminal station departure times in a range of plus or minus five minutes versus the Business Plan schedules were made to provide sufficient train set turnaround time at the terminal stations.
- Revisions to intermediate station dwell times were made within a range of from one minute to three minutes to minimize the adverse impact of local trains making line station stops with express trains following from behind.
- The TPC simulations produced an optimal express trip time of one hour, eight minutes and thirty seconds between San Diego (Qualcomm) and Los Angeles. This trip time is nine minutes longer than the trip time goal defined in the Business Plan and reflected in the conceptual service plan schedules. Consequently, the schedules of all trains providing service between San Diego and Sacramento and San Diego and San Francisco/Oakland were modified, as necessary, to account for the increase of nine minutes difference in the minimum achievable running time over this segment of the route.
- The TPC simulations produced an optimal express trip time of one hour, seventeen minutes and twenty seconds between San Jose and Sacramento (specifically via the UPRR Corridor to Lodi and crossing over to the BNSF at LODI to bypass Stockton, crossing back over to the UPRR alignment north of Stockton). This trip time is five minutes longer than the trip time goal defined in the Business Plan and reflected in the conceptual service plan schedules. Consequently, the schedules of all trains providing service between Sacramento and San Francisco/Oakland were modified, as necessary, to account for the difference of five minutes in minimum achievable running time over this segment of the route.

3.1.5. Shared Use Corridors

The Authority has assumed that the High Speed Train will operate between San Jose and San Francisco on an electrified, four track, grade separated corridor. Presently, high speed trains capable of 350 kph (220 mph) speeds are not designed to conform with all requirements for sharing track with conventional rail operations, including the current generations of passenger equipment operated by Amtrak and regional rail authorities, and freight equipment currently operated by the freight railroads. Where high speed and conventional rail operations must share right-of-way, the incompatibility issues must be resolved. This section will describe how High Speed Train operations were considered in potential shared use corridors along the Caltrain; Downtown San Francisco; and LOSSAN corridors.

CALTRAIN

The Program Environmental Process Model was used to simulate the CA HSR Business Plan Schedules assuming that a minimum of two of the four potential mainline tracks between San Jose and San Francisco would be available for express train (limited stop) services and that Transbay Terminal would be configured to accommodate both HST and Caltrain services. As future service plans for Caltrain are developed along with capacity and speed improvement alternatives, it is anticipated that further integrated shared use simulation analysis will be performed to validate the feasibility of capacity assumptions and refine train schedules to exploit the benefits of a joint operating plan solution.

As a precursor to performing further shared use corridor simulation modeling with Caltrain, a concept level operations review was made of the Caltrain Peninsula Line to and from San Francisco to identify prominent issues associated with the implementation of high speed rail service on this route. The results of this examination revealed that:

- In order to support both the number of CA HSR trains described in the Business Plan schedules with planned levels of Caltrain commuter rail trains will require four main tracks between CP Coast (a point on the rail line located north of Diridon Station) and San Francisco.
- Stations designated to serve trains operating on express tracks will require safe and comfortable pedestrian access/egress to platform(s)
- It is assumed that high speed trains will operate at a maximum speed of 125 mph along this route. Consideration should be given to operating Caltrain service that may share the use of express tracks with high speed trains at compatible speeds to minimize overtake delays that could adversely affect high speed train trip times and schedule compliance. Differences in running speeds for trains operating on shared use tracks will also influence degradation in line capacity for the affected track.
- All highway crossings will have to be either grade separated or eliminated due to the four main tracks previously described and the level, speeds and frequency of trains.
- Caltrain is planning to electrify the system in the future. Consideration should be given to the electrical compatibility of high speed trains with this proposed system.

LOSSAN

The LOSSAN Corridor is composed of the rail line between Los Angeles Union Station (LAUS) and Downtown San Diego. It is presently California's most highly developed rail service, second only to the Northeast Corridor in conventional passenger train service and ridership. This corridor serves a multitude of California's key coastal population centers and connects two of the most congested regions of the country; Los Angeles and San Diego.

The LOSSAN Corridor option examined for potential HST service would share the existing LOSSAN rail line from southeast Los Angeles (at LAUS) to Irvine with conventional passenger trains. It is important to note that in this scenario, precise operating synergies would have to be developed because high speed trains would share tracks with intercity (Amtrak) and commuter rail (SCRRA) services.

An operations simulation model was built to represent the physical and service characteristics of the rail line between LAUS and San Diego Terminal with a focus on capacity in the HST study area as far as Irvine to evaluate the wide range of improvements possible within this segment of the corridor, although the "High Build" Option is the only alternative that provides for the complete grade separation necessary for the operation of HST service. The dynamic train simulations that were developed for this analysis were defined as follows:

- Base Case Model – Existing conditions within the study area; present infrastructure configuration and March 2003 train services for Amtrak, SCRRA, BNSF and UPRR.
- LOSSAN No Project Case Model – Train service levels projected for the year 2025; infrastructure characteristics that assume project improvements that were programmed and funded as September 1, 2002. These assumed improvements include:
    - The LAUS Terminal "Run – Through" Project
    - Los Angeles County 3rd Main Track Projects between LAUS and Fullerton
    - 2nd Main Track Projects at Lincoln Avenue, San Onofre, O'Neil to Flores, Santa Margarita River, Oceanside, San Dieguito, Encinitas, Miramar Hill, and False Bay/Tecolote Creek
- LOSSAN "Low" Build Case Model – Train service levels projected for the year 2025; Infrastructure characteristics that assume project improvements that were identified by September 1, 2002, but not programmed or funded at that time. These assumed projects include:
    - Los Angeles County 4th Main Track Projects between LAUS and Fullerton
    - Track improvements to support a maximum speed of 110 mph (FRA Class 6)
    - Fullerton Station to Irvine At Grade track realignment project
    - San Juan Capistrano At Grade and Trench track realignment projects
    - San Clemente Projects: Dana Point Curve Realignment; San Clemente Short Tunnel; 2nd Main Track crossing San Mateo Creek and San Onofre Creek
    - San Onofre/Oceanside/Camp Pendelton 2nd Main Track Projects; crosses the Santa Margarita River
    - Oceanside to Encinitas At Grade alignment and 2nd Main Track Projects – over San Luis Rey, Buena Vista Aqua Hedionda and Batiquitos Lagoons.
    - Encinitas/Solana Beach track At Grade track realignment and 2nd Main Track; crosses San Elijo Lagoon
    - Del Mar Projects: Del Mar Re-Alignment Project – Solana Beach Station to the I-5/805 Split – Tunnel under Camino Del Mar; crosses San Dieguito and Los Penasquitos Lagoons
    - I-5/805 Split to Highway 52 Realignment Project – I-5 Tunnel
    - Highway 52 to Sante Fe Depot – Curve Realignment and 2nd Main Track Project; crossing the San Diego River Bridge and Trench between Sassafras Street and Cedar Street.
- LOSSAN "High Build" Case Model – Train service levels projected for the year 2025; Infrastructure characteristics that assume project improvements that were identified by September 1, 2002, but not programmed or funded at that time. Theses higher level

infrastructure improvements provide the same track and alignment characteristics as the "Low Build" Case with the following modifications:

- The Fullerton Station to Irvine Station track realignment project is in a Trench versus At Grade
- Track improvements to support a maximum speed of 125 mph (FRA Class 7)
- San Juan Capistrano adds a 2nd Main Track and Tunnel (under the Trabuco Creek and San Juan Creek) along I-5 between Highway 73 and Avenida Aeropuerto at San Juan Capistrano
- San Clemente Projects: Dana Point to San Clemente 2nd Main Track Project is composed of a long two segment tunnel instead of the short tunnel described in the "Low Build" Case.
- Oceanside to Encinitas alignment and 2nd Main Track Projects are in a Trench versus At Grade at Carlsbad
- Encinitas/Solana Beach track realignment is in a Short Trench versus At Grade
- Del Mar Projects: Del Mar Track Realignment is located in a Tunnel along I-5 versus a Tunnel under Camino Del Mar
- I-5/805 Split to Highway 52 realignment project is located in a Tunnel at Miramar Hill versus along I-5

The average number of daily weekday trains operating between LAUS – Fullerton - Orange assumed in the simulation model for the year 2025 were:

- Amtrak: 32 trains versus 22 trains in 2003
- Metrolink: 58 trains versus 28 trains in 2003

The average number of daily weekday trains operating between Orange and Irvine assumed in the simulation model for the year 2025 were:

- Amtrak: 32 trains versus 22 trains in 2003
- Metrolink: 58 trains versus 31 in 2003

The average number of daily weekday NCTD trains operating between Oceanside and San Diego assumed in the simulation model for the year 2025 were 54 versus 21 in 2003.

The projected rail service for the year 2025 applied to the No Project, Low Build and High Build Cases were based upon the following sources:

- Amtrak:
  - California Passenger Rail System – 20 Year Improvement Plan, March 2001
  - LAUS Run Thru Tracks Project Consolidated Arrival & Departure Schedule, Draft Revision 7 dated November 17, 2002.
- Metrolink:
  - Metrolink 2020 projections based upon the SCRRA 30 Year Strategic Plan
  - LAUS Run Thru Tracks Project Consolidated Arrival & Departure Schedule, Draft Revision 7 dated November 17, 2002

- BNSF:
  - Based on 2020 projections derived from LAEDC Growth Rate Projections, July, 2002 for the L.A. to Fullerton segment
  - Based on 2020 projections derived from SANDAG 2020 population and employment forecasts fro the Oceanside to San Diego segment.
- NCTD:
  - Based on 2020 projections derived from the SANDAG Regional Transportation Plan ; 20 minute peak headways, 60 minute off-peak Headways.

The "No Project", and "Low Build" and "High Build project programs provide significant capacity enhancements between LAUS and Fullerton with the addition of Third and Fourth main tracks respectively. It is important to note that the double track (second main track) projects planned for the Corridor between Fullerton and San Diego are significant capacity elements of the overall Corridor improvements when LOSSAN is viewed as a holistic integrated train service network. These double track projects provide synergy in the capacity between the rail network from Irvine to San Diego and the corridor segment between Irvine and LAUS (that will benefit from the installation of the Third and Fourth main tracks in Los Angeles County). The combination of these project improvements will together yield the potential capacity, reliability and trip time benefits expected over the entire length of the LOSSAN Corridor. Considering the projected 2025 service increases for Amtrak, SCRRA (Metrolink) and NCTD (Coaster), any segments of single track remaining in either Orange or San Diego Counties could present a potential "chokepoint", having a cascading effect on the performance of trains between Irvine and LAUS, offsetting some of the benefits achieved with the projects between LAUS and Fullerton. The reliability of the existing passenger services on this line is dependent on congestion at such chokepoints.

3.1.6. Model Results

One of the objectives of simulating the train operations and improvements assumed for the LOSSAN Corridor in 2025 was to estimate capacity on the segment between LAUS and Irvine to determine the feasibility of this segment to support high speed train service. The results of the model analysis revealed that the No Project configuration could not feasibly support additional rail service given the assumptions on the number of trains and physical plant.

Although there are several differences between the Low-End Build and the High-End Build options, these variations provide solutions that improve travel time but do not measurably affect capacity (i.e. the number of main tracks to support the train volumes assumed for 2025). As stated in the description of the "Low Build" and "High Build" both cases include four main tracks between LAUS and Fullerton with the remainder of the Corridor double tracked. The "Low Build" improves maximum running speed to 110 mph (FRA Class 6) while the "High Build" assumes a top speed of 125 mph (FRA Class 7) and full grade separation. In summary, the infrastructure improvements associated with the two Build options provide increased operating speeds and a measurable decrease in trip times.

Comparing the optimal express trip time for the High Build option with the Low Build the travel time between Los Angeles and San Diego is one hour twenty-eight minutes versus one hour thirty-eight minutes; the High Build is ten minutes faster. For a similar comparison between the High Build and No Project, the travel time is one hour twenty-eight minutes versus two hours five minutes; the High Build is thirty-seven minutes faster. A similar comparison of trip times for the Low and High Build versus the No Project is not applicable on a corridor-wide comparison, since express service is not feasible given the capacity constraints of the No Project scenario. The existing scheduled travel time including station stops and "pad" is between two hours forty minutes and two hours forty five minutes, with no project improvements the estimated scheduled time is two hours thirty-six minutes. Similarly, the estimated scheduled travel time for the “Low Build” is one hour fifty-eight minutes and for the “High Build” the estimated scheduled travel time is one hour forty-eight minutes.

Comparing the average running speeds between LAUS and San Diego for each of the simulated optimal express trip time scenarios, the High Build is 84 mph and the Low Build is 76 mph. The average running speed for the High Build is 8 mph faster (10%) then the Low Build.

The San Clemente projects were examined in the model to identify detailed reductions in trip times between the High Build and Low Build scenarios. The eleven mile segment that includes these project improvements was defined in the simulation and the results indicated that the trip time over this segment in the High Build was seven minutes with an average speed of 97 mph while the Low Build yielded a trip time of eight minutes and an average speed of 85 mph. Under the No Project scenario the simulation yielded a trip time of eleven minutes over this segment.

The Del Mar projects were similarly examined in the model at a detailed level. The six mile segment that encompasses these project improvements was defined in the simulation and the results indicated that the trip time over this segment in the High Build was four minutes with an average speed of 91 mph versus a trip time of five minutes and an average speed of 91 mph in the Low Build. Under the No Project scenario the simulation yielded a trip time of six minutes over this segment.

The High Build offers the advantage of two differentiating improvements versus the Low Build: 1.) maximum operating speed is 125 mph in the High Build versus 110 mph in the Low Build; 2.) the High Build Program includes projects that provide shorter distances (in some cases), improved curve geometrics and a fully grade separated Corridor. Both the Low-End Build and High-End Build options support the increase in Amtrak service forecast for the year 2025.

It is important to note that the Low-end build option is not fully grade separated. Currently, the assumption for shared use operations with the HST are only being considered on fully grade separated corridors. Consequently, the model results used to estimate the potential to introduce high speed trains is applied to only the High-End Build configuration.

The simulation of the High-End Build case assumed a physical separation between freight and passenger trains; specifically that freight and passenger trains would be segregated to operate on their own tracks between LAUS and Fullerton where four main tracks are envisioned. On this corridor segment (in the model) the freight trains were assumed to occupy two main tracks and the passenger trains were similarly confined to two main tracks. Therefore, the focus of the simulation analysis was to estimate the number of high speed trains that could feasibly be operated over this route in addition to the number of Amtrak and Metrolink trains assumed for 2025. The results of the model analysis indicated that between 18 and 45 HST trains per day in each direction (depending on when the HST are scheduled and the effectiveness of the joint operating plan between Amtrak, Metrolink and the HST operator) could be supported along this part of the corridor at an optimal express trip time of 37 minutes and a peak traffic dispatch trip time ranging between 39 and 43 minutes from LAUS to Irvine. The minimum of 18 and maximum of 45 trains identified in this scenario are estimated to be the range of high speed trains that could be introduced in this shared use corridor given the assumed level of Amtrak and Metrolink service (number of trains) and frequency (timetable schedules) provided for the year 2025.

It is important to note the modeling dynamics revealed that if the segregation of freight and passenger trains were to be implemented the interlockings at the approaches to LAUS and through Fullerton would likely have to be reconfigured to efficiently route trains to the appropriate main tracks at these locations. Furthermore, the passenger stations (such as Norwalk and Fullerton) along this route would have to be modified by positioning their platforms adjacent to the appropriate tracks and providing grade separated pedestrian access/egress.

3.1.7. Other Issues

ORANGE COUNTY SERVICE

Union Pacific Railroad Santa Ana Branch Line: The UPRR Santa Ana Branch is a potential HST dedicated route option that traverses largely industrial and commercial areas via an at grade alignment. It extends 46 kilometers from southeast Los Angeles to a station in Central Orange County at Anaheim. The optimal express trip time simulated for this option is 16 minutes with approximately fifty percent of the length of the alignment capable of supporting a maximum speed of 290 kph. Assuming a double track configuration, this alternative is estimated to have sufficient practical capacity for 20 trains per hour in each direction operating on 3 minutes headways.

LAUS to Irvine Transportation Center (LOSSAN Electrified): The route option from LAUS to a station in Central Orange County at the Irvine Transportation Center assumes an electrified, high speed rail line generally within the envelope of the existing LOSSAN Corridor right of way. Assuming HST service with a maximum speed of 250 kph and optimal timing (minimal impedance by other trains), the optimal simulated express trip time for this option is 28 minutes over a distance of 71 kilometers.

LAUS/Southeast LA Country to LAX

LAUS to LAX: This route option from LAUS providing a direct link to LAX is 25 kilometers with a simulated trip time of 13 minutes. Due to the short distances between twelve prominent curves in the alignment, it presents a slow route with an estimated average speed of 112 kph (69 mph).

Appendix A

Appendix B

Appendix C

Appendix D

Appendix E